Office of Operating Experience Analysis, EH-33 • U.S. Department of Energy • Washington, D.C. 20585

OPERATING EXPERIENCE
WEEKLY SUMMARY

Office of Nuclear and Facility Safety

May 8 - May 14, 1998

Summary 98-19

Operating Experience Weekly Summary 98-19

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EVENTS

1. CRITICALITY INFRACTIONS AT ROCKY FLATS

This week OEAF engineers reviewed two recent criticality infractions at the Rocky Flats Environmental Technology Site. On May 4, 1998, plutonium fabrication pyrochemical operations personnel discovered that a non-conservative uncertainty assumption was used to derive criticality safety limits for processing salts. On May 5, 1998, an operations criticality safety officer determined that sand, slag, and crucible operators failed to control plutonium mass values during bag-out operations as required by operating procedures. Facility managers terminated operations until controls can be implemented to prevent further criticality infractions. Infractions of criticality safety limits may lower the margins of criticality safety. (ORPS Reports RFO--KHLL-PUFAB-1998-0036 and RFO--KHLL-371OPS-1998-0032)

Investigators of the May 4 event determined that material processed through a segmented gamma scanner contained metal chunks that affected the scanner results. They also determined that operators performed previous scanner verifications using a plutonium powder that was not representative of the material actually being processed. The salts process requires processing plutonium cans by dividing the material into small batches, then repackaging them. Investigators determined that procedures require operators to verify the criticality safety limits for the repackaged material using the segmented gamma scanner. They determined that these limits were based on the assumption that scanner uncertainty was 10 percent. Facility personnel based the 10 percent uncertainty on the manufacturer’s uncertainty data and on verifications that operators performed using plutonium powder. Facility personnel reviewed past scanner processing results and determined that scanner uncertainty may be as high as 40 percent for non-uniform distributions. Investigators determined that the criticality safety limits for the salt process are not conservative and that facility personnel must revise them to reflect the higher uncertainty. The facility manager continues to investigate this event.

For the May 5 event involving plutonium mass values, investigators determined that on two different occasions operators processed containers of plutonium residues from the casting process and recorded the estimated plutonium gram value for the processed material cans in accordance with procedures. However, an operations order modified the procedure and required operators to record the criticality safety value (which is the fissile mass value from the original residue container) on each can. Investigators determined that the process involved obtaining a container of plutonium residues, grinding its contents, blending it to achieve a homogenous mixture, and repackaging the plutonium residues into storage cans. Operators are required to assign the criticality safety value from the original residue container to each of the new cans until the homogenous mixture is verified. However, operators recorded the estimated plutonium gram value on each can instead of the criticality safety value. Investigators determined that, although no criticality infraction occurred, the procedural violations could have resulted in a criticality limit infraction. The facility manager continues to investigate this event.

NFS has reported criticality safety infractions at Rocky Flats in several Weekly Summaries. Following are some examples.

- Weekly Summary 97-46 reported that a DOE facility representative observing residue-sampling operations noticed that two containers were not stored in designated fixed positions in a storage cabinet, violating criticality spacing requirements. Investigators determined that the residue-sampling team also violated procedures when they opened a drum containing fissionable material without obtaining a criticality safety evaluation or determining criticality safety limits. (ORPS Report RFO--KHLL-371OPS-1997-0096)

- Weekly Summary 96-37 reported that workers moved drums into a storage area with previously infracted drums resulting in a criticality safety violation. Corrective actions included improving communications between operations staff and criticality safety engineers. (ORPS Report RFO--KHLL-771OPS-1996-0148)

- Weekly Summary 97-02 reported that a criticality safety officer identified four criticality safety infractions during an on-going criticality safety walk-down. She found air filters stored in a glovebox that did not meet spacing requirements, part carriers that did not meet the spacing requirements, and two carts with expired building nuclear material safety limits. She also found that no one had posted the most current limit requirements of the interplant manual for drum movement. (ORPS Report RFO--KHLL-SOLIDWST-1996-0169)

OEAF engineers searched the ORPS database for events with a nature of occurrence of nuclear criticality safety from January 1990 to present and found 550 occurrences. Figure 1-1 shows the distribution of root causes for nuclear criticality safety issues. A review of these occurrences shows that managers reported 46 percent of the root causes as management problems and 23 percent as personnel errors. Further review of the management problems shows that 41 percent were reported as inadequate administrative control, and 24 percent were reported as policy not adequately defined, disseminated, or enforced. Further review of the personnel errors shows that 54 percent were reported as inattention to detail and 28 percent as procedure not used or used incorrectly.

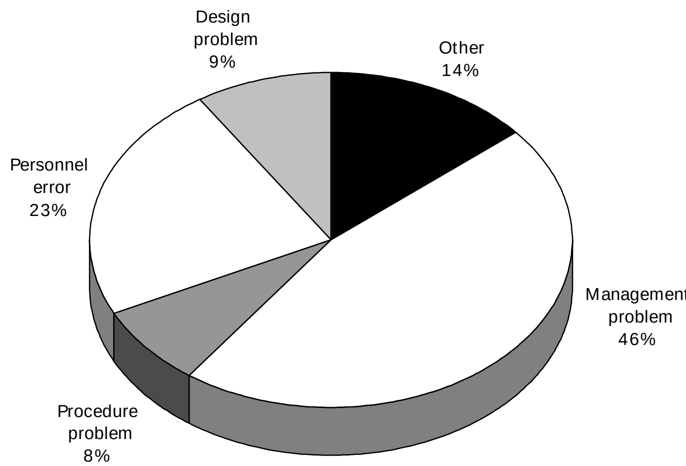

Figure 1-1. Root Causes for Nuclear Criticality Safety Issues[1]

In December 1996, DOE issued DOE/EH-0525*, Highly Enriched Uranium Working Group Report*. The report stated that workforce reductions "have hampered the ability of the nuclear criticality safety and maintenance groups" and that "responsible operating personnel are not knowledgeable of the forms or kinds of materials present." It concluded that a "lack of criticality safety responsibility by operations managers results in inadequate support and prevents effective oversight." It also concluded that "corrective actions are typically inappropriate and untimely, and communication between operations and nuclear criticality safety personnel is poor."

In the first event, criticality safety personnel did not verify that all assumptions used to set limits were valid before beginning operations with fissile materials. In the second event, facility personnel bypassed the operational procedure system of review and approval and issued an operations order instead of correcting the procedure.

Facility managers should ensure that all operators and supervisors are familiar with operating procedures and understand their purpose and use. This is even more important when criticality safety issues are involved.

- DOE O 420.1, *Facility Safety,* provides direction on establishing criticality safety program requirements. Section 4.3, "Nuclear Criticality Safety," invokes the requirements of several ANSI/ANS standards, including those contained in ANSI/ANS-8.19-1984.

- DOE O 5480.19, *Guidelines for the Conduct of Operations Requirements for DOE Facilities*, provides guidance on sound operating practices and invokes several ANS standards for basic elements and control parameters in programs for nuclear criticality safety.

[1] OEAF engineers searched the ORPS database using the graphical user interface for reports with a nature of occurrence code of "1A" (nuclear criticality safety) from January 1990 to present and found 550 events.

- DOE P 450.4, *Safety Management System Policy*, discusses guiding principles for integrated safety management and states that "personnel shall possess the experience, knowledge, skills, and abilities that are necessary to discharge their responsibilities."

- ANSI/ANS-8.19-1984, *Administrative Practices for Nuclear Criticality Safety,* provides the criteria for administration of an effective nuclear criticality safety program for operations outside of reactors in which there exists a potential for criticality accidents. Sections 4, 5, and 6 address responsibilities for managers, supervisors, and members of the nuclear criticality safety staff. Section 7, "Operating Procedures," provides information about the purpose, use, and review of procedures. Section 7.1 states that procedures should be organized, presented for convenient use by operators, and free of extraneous material.

- DOE-STD-1029-92, *Writer's Guide for Technical Procedures,* provides guidance for preparing procedures used at DOE facilities. The standard states that "procedures must be technically and operationally accurate, up-to-date, and easy to follow, or workers will lack confidence in them and may not use them."

KEYWORDS: criticality safety, procedures, operations

FUNCTIONAL AREAS: Nuclear/Criticality Safety, Procedures, Management

2. OPERATORS INSERT EXPERIMENT CAPSULE IN WRONG POSITION

On May 5, 1998, at the Idaho National Environmental Engineering Advanced Test Reactor Facility, a facility manager reported that operators inserted an experiment capsule into the wrong capsule irradiation position. Because the capsule was in the wrong position, it was not discharged from the reactor as scheduled and was over-irradiated. The facility manager directed operators to complete a full inventory of all other experiment irradiation positions. They determined there were no other reactor experiment loading anomolies. Nuclear Safety Technical Support personnel reviewed the experiment safety analysis report and determined that inserting the capsule in the wrong core position and over-irradiating it did not constitute a safety concern. (ORPS Report ID--LITC-ATR-1998-0008)

Investigators determined that on May 5, operators realized that the hardware removed from the capsule irradiation position was a solid flow restrictor, not the experiment capsule. They determined that during a previous outage operators had inserted a solid flow restrictor assembly into the capsule irradiation position meant for the experiment capsule. They also determined that because the flow restrictor was in the capsule irradiation position meant for the experiment capsule, operators discharged it in a subsequent outage and placed it in a canal location for storage. Investigators learned that when facility personnel determined that the discharged item was a solid flow restrictor, they performed an extensive review of records and a full inventory of other possible canal locations to locate the experiment capsule before they found it in another capsule irradiation position. Investigators also determined that reactor experiment loading records mistakenly showed that the capsule had been discharged from the capsule irradiation position on April 3. They also determined that the experiment results were compromised because (1) the experiment was irradiated for approximately 2 weeks longer than requested and (2) the position where the experiment capsule was found has a slightly higher neutron flux than the specified position.

The facility manager held a critique of the event. Critique members learned that on January 30, 1998, two operators mistakenly inserted the experiment capsule into the wrong position. Critique members also learned that the operators had incorrectly performed a visual inventory verification and incorrectly determined that the experiment was loaded in the correct position. During the next scheduled outage, two other operators discharged what they believed was the experiment capsule. They noticed that the “experiment capsule” looked like a flow restrictor, but they did not question it or report it. Critique members learned that solid flow restrictors and experiment capsule holders look nearly the same. After the operators discharged the flow restrictor, they placed it in a divided transfer bucket; labeled the bucket to show it contained the experiment capsule; and placed the bucket in the canal for storage. After reactor start-up, operators unsuccessfully attempted to perform visual verifications of the bucket contents. They did not recognize that the bucket actually contained a solid flow restrictor because they could not read any numbers inscribed on the side of the flow restrictor. The facility manager continues to finalize corrective actions to address the following problems.

- Operators performed dual verification checks of the experiment irradiation positions, but not independent verifications (as specified in operating procedures), and they were not sensitive to the difference between dual and independent verifications. Dual verifications are performed simultaneously when components are positioned; independent verifications are performed independent of activities related to establishing the component position.

- The operating procedure did not require operators to visually check all capsule irradiation positions before closing the reactor vessel.

- The operating procedure did not require operators to perform physical inventories of capsule irradiation positions after experiments were inserted.

- The operators who removed the solid flow restrictor from the capsule irradiation position did not question why it looked like a solid flow restrictor instead of an experiment capsule.

- The operators were not sufficiently trained to recognize the difference between a solid flow restrictor and an experiment capsule when looking at the top of the assembly. This led to a delay in recognizing the discrepancy.

The facility manager also determined that facility personnel need to re-examine the policy of allowing the experiment capsules to remain in divided storage buckets until after reactor re-start is complete. He also determined that the difficulty of reading numbers inscribed on the side of experiment capsules must also be addressed.

NFS has reported events caused by operator error in several Weekly Summaries. Following are some examples.

- Weekly Summary 98-04 reported that an operator error at the Sandia Pulsed Reactor Facility resulted in a premature initiation of a reactor pulse. Investigators determined that two operators were preparing to conduct pulse operations on an experiment package. The operating procedure called for confirmation of reactor pulse element reactivity worth by performing a transient that is super-critical, but slightly below prompt critical. The operators used data from a very similar experiment configuration and pulse conducted in December 1997 to establish the reactor pulse configuration. They recognized that there was a difference in reactivity from the previous pulse, but attributed the difference to an experiment configuration change (additional data cables) that would not impact reactor pulse performance. Instead of a power transient (slightly below prompt critical) the resulting operation was a small pulse (slightly above prompt critical). (ORPS Report ALO-KO-SNL-6000-1998-0001)

- Weekly Summary 97-38 reported that an operator error at the Los Alamos National Laboratory resulted in a scram of the solution high-energy burst assembly during a subcritical operation. The operator failed to verify adequate vacuum in a purge gas accumulator as required by a pre-operational checklist, and a vacuum sensor for the accumulator sent a signal to the scram circuit causing the scram. (ORPS Report ALO-LA-LANL-TA18-1997-0012)

- Weekly Summary 97-09 reported that operators at the Idaho National Engineering Laboratory Advanced Test Reactor failed to recognize that reactor confinement requirements were not met when they moved an experiment cask over the fueled reactor vessel. Investigators determined that shift supervisors failed to conduct proper reviews of the physical status of the facility. They also determined that had the cask dropped and compromised fuel integrity, a radioactive release to the environment could have resulted. (ID--LITC-ATR-1997-0005)

These events underscore the importance of operators maintaining questioning attitudes and paying attention to detail to ensure configuration control is maintained. Configuration control is important to ensure safe operation, testing, and maintenance of facility equipment and systems. In addition, if operators had correctly performed independent verifications, this event could have been prevented. Operators should be trained in the importance of questioning attitudes and attention to detail. They also must be trained in how to correctly perform independent verifications.

These events also demonstrate the importance of multiple, engineered barriers to prevent hazardous events such as inadvertent criticality. Human performance, supported by procedures, policies, memoranda, or standing orders, is a barrier to preventing criticality events. However, the probability of prevention should be increased by adding physical barriers. In this event, not only did multiple human barriers fail, but procedural barriers also failed. When multiple barriers fail, managers should investigate to determine if broad programmatic deficiencies exist.

Facility managers should review the following documents to ensure that (1) operations personnel understand their responsibilities and (2) management policies and procedures exist that address proper configuration controls and operator verifications.

- DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, chapter II, “Shift Routines and Operating Practices,” states that the on-duty shift supervisor maintains authority and responsibility for all facility operations. The Order also states that it is the responsibility of the on-shift operating crew to safely operate the facility through adherence to operating procedures and to technical specifications, operational safety requirements, and sound operating practices. Chapter VIII, “Control of Equipment and System Status,” discusses the control and status of equipment and states that the operations supervisor is responsible for maintaining proper configuration. Chapter X, “Independent Verification,” states that independent verification programs should provide a high degree of reliability in ensuring the correct position of components. It defines independent verifications as the act of checking a component position independent of activities related to establishing position of the component. Chapter XI, "Logkeeping," provides guidelines on establishing operating logs, recording information, ensuring legibility of entries, and performing reviews of logs.

- DOE/EH-0502, Safety Notice 95-02, "Independent Verification and Self-Checking," describes a technique that requires workers to (1) stop before performing the task to eliminate distractions and identify the correct component; (2) think about the task, expected response, and actions required if that response does not occur; (3) act by reconfirming the correct component and performing the function; and (4) review by comparing the actual versus the expected response.

KEYWORDS: operations, reactor, experiment, critical

FUNCTIONAL AREAS: Nuclear/Criticality Safety, Operations

3. INADEQUATE CONTROL OF HAZARDS

On March 16, 1998, at the Idaho National Engineering and Environmental Laboratory, the DOE manager of the Waste Reduction Operations Complex transmitted a surveillance report to the Complex contractor manager identifying deficiencies in the operating contractor's program for controlling worker exposure to lead and cadmium at the Waste Experimental Reduction Facility incinerator bag house. On April 28, 1998, the DOE manager transmitted another surveillance report to the Complex contractor manager expressing serious concerns regarding the adequacy of the contractor's hazard evaluations for lead, cadmium, and confined spaces at the Waste Experimental Reduction facility. The facility manager prohibited entry into the bag house until effective engineering and administrative hazard controls can be implemented. Inadequate hazard analysis and control resulted in at least one worker being exposed to airborne lead and cadmium dust that exceeded OSHA permissible exposure limits. (ORPS Report ID--LITC-WERF-1998-0004)

Site physicians evaluated all Waste Experimental Reduction Facility operators for lead, cadmium, and beryllium exposure and enrolled them in routine medical surveillance programs for lead, cadmium, and beryllium. They included beryllium in the surveillance program to establish baselines because future waste streams may include beryllium. None of the operators showed any sign of lead, cadmium, or beryllium uptakes.

Investigators determined that Waste Experimental Reduction Facility managers and assigned environmental, safety, and health professionals did not ensure that hazard evaluations and safety reviews were adequate to identify requirements for worker protection and ensure compliance with them. Investigators also determined that hazard evaluations and safety reviews failed to identify lead and cadmium hazards because the facility does not have a written lead and cadmium regulation compliance program. Until an effective program can be developed and implemented, the facility industrial hygienist will evaluate hazards associated with required maintenance activities and develop appropriate engineering and administrative controls to address them.

NFS has reported on inadequate job hazard analysis in several Weekly Summaries. Following are some examples.

- Weekly Summary 98-14 reported that facility managers at the Savannah River Technology Center determined that elements of the lead compliance program did not provide adequate guidance to protect workers. Based on program deficiencies identified by facility managers, the Center operations manager curtailed all Center lead handling performed without facility industrial hygienist approval. (ORPS Report SR--WSRC-LTA-1998-0012)

- Weekly Summary 98-13 reported that two electricians at the Los Alamos National Laboratory Accelerator Complex received burns to their hands and faces when vapors from an aerosol electrical contact cleaner they were using contacted an electrical space heater, ignited, and formed a fireball. Investigators determined that use of the space heater was not specified in the work package, and they believed that no one performed a chemical hazard analysis before the electricians began work. (ORPS Report ALO-LA-LANL-ACCCOMPLEX-1998-0005)

- Weekly Summary 96-05 reported that two operators and a health physicist at Hanford Analytical Laboratory were exposed to hazardous vapors while working in a contamination confinement structure. The exposure was a result of operators wearing powered air purifying respirators that were inappropriate for the confined atmosphere. Investigators determined that no one reviewed the material safety data sheet for a stripcoat that the operators used during preparation of the work package or during the pre-job briefing. (ORPS Report RL--WHC-ANALLAB-1996-0006)

These events underscore the importance of performing a thorough activity hazard analysis. Industrial hygienists and facility managers responsible for developing hazard management programs, conducting hazard analyses, or specifying medical monitoring (including baseline medical data collection) should review the following references for guidance on lead, cadmium, and confined spaces.

- DOE 440.1A*, Worker Protection Management for DOE Federal and Contractor Employees*, requires all DOE elements to identify existing and potential workplace hazards and evaluate the risk of associated worker injury or illness. The Order also requires DOE elements to assess worker exposure to chemical, physical, biological, or ergonomic hazards through appropriate workplace monitoring (including personal, area, wipe, and bulk sampling), biological monitoring, and observation.

- DOE 5480.4, *Environmental Protection, Safety and Health Protection Standards*, requires compliance with many regulations and permits, such as the Resource Conservation and Recovery Act. The Act specifies treatment, storage, and disposal requirements for hazardous materials such as lead from “cradle to grave.” Failure to comply exactly with these environmental regulations can result in civil penalties.

- 29 CFR 1910.1025, *Lead*, applies to employees who may be occupationally exposed to lead. The regulation states that the employer shall ensure that no employee is exposed to lead at concentrations greater than 50 micrograms per cubic meter of air averaged over an 8-hour period. The regulation also specifies how employers should implement employee protective measures, including respiratory protection, awareness training, and physical monitoring.

- 29 CFR 1910.1027, *Cadmium*, applies to employees who may be occupationally exposed to cadmium. The regulation states that the employer shall ensure that no employee is exposed to cadmium at concentrations greater than 5 micrograms per cubic meter of air averaged over an 8-hour time period. The regulation also specifies how employers should implement employee protective measures, including respiratory protection, awareness training, and physical monitoring.

- 29 CFR 1910.1000, *Air Contaminants*, states that the permissible exposure limit for beryllium is 2 micrograms per cubic meter of air averaged over a 8-hour period; 5 micrograms per cubic meter of air as an acceptable ceiling during an 8-hour work shift; and 25 micrograms per cubic meter of air as a maximum peak above the acceptable ceiling concentration, which is not to be exceeded during any 30-minute work period for beryllium and beryllium compounds. However, the National Institute for Occupational Safety and Health recommended beryllium airborne exposure limit is 0.5 micrograms per cubic meter of air, not to be exceeded for any length of time.

- 29 CFR 1910.146, *Permit-Required Confined Spaces*, contains requirements for practices and procedures to protect employees from hazards of entry into permit-required confined spaces. The standard requires employers to develop and implement the means, procedures, and practices necessary for safe permit space entry operations, including (but not limited to) the following.

  – identifying and evaluating permit space hazards before entry
  – establishing and implementing means to prevent unauthorized entry
  – establishing and implementing means to eliminate or control hazards necessary for safe entry
  – providing, maintaining, and requiring the use of personal protective equipment necessary for safe entry
  – requiring testing of atmospheric conditions inside the space before entry
  – ensuring that at least one attendant is stationed outside during entry
  – coordinating with any contractors used
  – implementing rescue procedures
  – establishing a written permit system
  – reviewing the permit system annually

Appendix A of OSHA 1910.146 provides a decision flow chart to assist personnel in implementing an effective confined space program. Appendix C of this standard provides examples of permit-required confined space programs.

- DOE/EH-0353P, *OSH Technical Reference Manual*, chapter 4, “Confined Space Entry,” provides a checklist for employees and supervisors to follow. This checklist is available on the Internet through the DOE Environment, Safety and Health Technical Information Services. It is located at URL http://tis.eh.doe.gov:80/docs/osh_tr/otr.

Inhalation is the primary means of taking lead into the body, although it may also be absorbed through the digestive tract. Acute lead exposure may result in seizures, coma, and death from cardiorespiratory arrest. Chronic lead exposure may result in severe damage to blood-forming, nervous, urinary, and reproductive organs.

Inhalation is also the primary means of taking cadmium into the body, although it may also be absorbed through the digestive tract. Acute cadmium exposure may result in flu-like symptoms of weakness, fever, headache, chills, sweating and muscular pain. Acute pulmonary edema usually develops within 24 hours and reaches a maximum by 3 days. If death from asphyxia does not occur, symptoms may resolve within a week. The most serious consequence of chronic cadmium exposure is cancer (lung and prostate). The first observed chronic effect is generally kidney damage.

Complete OSHA standards may be found at URL http://www.osha-slc.gov/. Additional information on occupational exposure to lead and cadmium may be found at URL http://www.osha-slc.gov/SLTC/Chemicals.html.

Information on environmental lead poisoning may be found at the National Lead Information Center. The Center may be reached at 800-LEAD-FYI. The Center also operates a clearinghouse (800-424-LEAD) staffed by trained information specialists who can provide in-depth technical information on lead-related issues. The Center's URL is http://www.nsc.org/ehc/lead.htm.

Additional information on DOE beryllium worker protection activities can be obtained by calling the Office of Worker Protection and Hazards Management at (301) 903-6061. Information on the DOE Chronic Beryllium Disease Prevention Program and the documents referenced herein can be obtained at URL http://tis-nt.eh.doe.gov/be/. National Institute for Occupational Safety and Health information regarding beryllium can be obtained at URL http://www.cdc.gov/NIOSH/. The Rocky Flats Environmental Technology site has a beryllium information site at URL http://www.dimensional.com/~mhj/bsg/rfets.html. Lawrence Livermore National Laboratory also maintains a beryllium information site at URL http://www_training.llnl.gov/training/hc/Be/Be.html.

KEYWORDS: hazard analysis, industrial hygiene, work planning

FUNCTIONAL AREAS: Industrial Safety, Work Planning

OEAF FOLLOW-UP ACTIVITY

1. CORRECTION TO WEEKLY SUMMARY 98-17, *PRICE-ANDERSON AMENDMENTS ACT (PAAA) INFORMATION*, ARTICLE 1

Article 1 in the Price-Anderson Amendments Act section in Weekly Summary 98-17 incorrectly stated that "site dosimetry personnel failed to identify and investigate area monitoring results above 75 mrem for six quarters." The articles should have stated that radiological engineering personnel failed to investigate area monitoring results above 75 mrem for six quarters. (NTS Report NTS-RFO-KHLL-SITEWIDE-1997-0009)

KEYWORDS: Price-Anderson Act

FUNCTIONAL AREAS: Licensing/Compliance, Radiation Protection